



Economic and Social Council

Distr.
GENERAL

E/C.7/1993/7
8 February 1993

ORIGINAL: ENGLISH

COMMITTEE ON NATURAL RESOURCES

First session

29 March-8 April 1993

Item 9 (a) of the provisional agenda*

CROSS-SECTORAL PRIORITY PROGRAMMES FOR COORDINATED ACTION BY THE UNITED NATIONS SYSTEM IN THE AREA OF WATER RESOURCES: INFORMATION MANAGEMENT

Report of the Secretary-General

SUMMARY

The integrated management of information concerning water resources, together with other physical, environmental, demographic and socio-economic data, is an essential component in the rational use and protection of finite and vulnerable water resources. Yet, the widespread absence of comprehensive information seriously impedes a meaningful monitoring of the water resources situation at the national, regional and global levels. The present report suggests that the objective of a monitoring system should be to act as an indicator of areas of opportunity, and as a warning system of areas at risk. Whenever possible, the unifying geographical unit for the treatment of information should be the watershed or groundwater basin.

The rapid evolution in the field of electronic data processing that took place during the 1980s has made a number of geographical information systems (GIS) readily accessible for use with personal computers. There are, difficulties, however, in their application, stemming from the limitations connected with the reading of data in various formats and those inherent in the very nature of remote sensing data. In 1992, the former Department of Technical Cooperation for Development of the United Nations Secretariat started a feasibility study on the interfacing of data stored in different programmes into a geographical information system. It is expected that a pilot programme will be conducted in the near future in order to test the applicability of such an interface and to assist Governments in strengthening their capacity for information management. At the global and regional levels, the organizations of the United Nations system are studying means to establish a system-wide integrated monitoring and assessment network with a view to monitoring the state of the world's freshwater resources.

* E/C.7/1993/1.

CONTENTS

	<u>Paragraphs</u>	<u>Page</u>
INTRODUCTION	1 - 4	3
I. OBJECTIVES AND SCOPE OF AN INTEGRATED INFORMATION SYSTEM	5 - 7	4
II. INFORMATION MANAGEMENT ISSUES AT THE NATIONAL LEVEL ...	8 - 22	5
A. The current situation	8 - 18	5
B. Proposals for enhancing capacity-building at the national level	19 - 22	8
III. INFORMATION MANAGEMENT AT REGIONAL AND GLOBAL LEVELS ..	23 - 30	9

INTRODUCTION

1. The Mar del Plata Action Plan of the United Nations Water Conference, held in 1977, called for an integrated approach to policy formulation, and the establishment of legislative and administrative guidelines, and recommended that countries should improve the availability and quality of necessary basic information. 1/

2. In Agenda 21 of the United Nations Conference on Environment and Development, the Conference stressed the need for "the holistic management of freshwater as a finite and vulnerable resource, and the integration of sectoral water plans and programmes within the framework of national economic and social policy". 2/ The Conference recognized the close interrelationship between water and other natural resources, as well as between water and other socio-economic factors. Thus, in Agenda 21, it was stated that all States could implement, inter alia, "integration of measures for the protection and conservation of potential sources of freshwater supply, including the inventorying of water resources, with land-use planning, forest resource utilization, protection of mountain slopes and riverbanks and other relevant development and conservation activities", 3/ and "development of interactive databases, forecasting models, economic planning models and methods for water management and planning, including environmental impact assessment methods". 4/ In addition, it was pointed out, also in Agenda 21, that prevailing systems of decision-making in many countries tend to separate economic, social and environmental factors at the policy, planning and management levels.

3. Owing to a widespread absence of comprehensive information for water resources management, a meaningful monitoring of water resources at the national, the regional and the global level has been fraught with serious difficulties. More often than not, critical information is not available or, if available, is not sufficiently timely, reliable or comprehensive. Most important, data on a diversity of physical, demographic, economic and social parameters that should be essential to planning and the management of water resources for sustainable development are (if and when available) often collected and processed in a fragmented manner lacking a holistic perspective on the type of data set required for such management. As noted in chapter 40 of Agenda 21, concerning information for decision-making, "there is a general lack of capacity, particularly in developing countries, and in many areas at the international level, for the collection and assessment of data, for their transformation into useful information and for their dissemination. There is also a need for improved coordination among environmental, demographic, social and developmental data and information activities". 5/

4. The present report presents the outlines of an incipient system-wide programme for addressing the current shortcomings with regard to information management in the light of monitoring requirements at the national, regional and global levels. The programme aims to address issues related to assisting Governments in establishing or strengthening their capacity to manage information in a manner suited to the integrated management of water resources. It also addresses issues related to the establishment of a network able to yield sufficiently comprehensive information for regional and global monitoring in the context of the Mar del Plata Action Plan and the follow-up to the

/...

Conference, particularly in the light of the call within Agenda 21 for a strengthening of "local, provincial, national and international capacity to collect and use multi-sectoral information in decision-making processes". 6/

I. OBJECTIVES AND SCOPE OF AN INTEGRATED INFORMATION SYSTEM

5. It is suggested that the objective of an integrated monitoring system should be to act, on the basis of analyses of reasonably reliable and timely data, as an indicator of areas of opportunity for sustainable socio-economic development, and as a warning system regarding current or future areas at risk, with a view to directing resources towards priority issues and urgent programmes.

6. For a system to be able to achieve this objective, it is necessary that data concerning key variables be stored and processed in such a manner as to provide a suitable understanding of the current situation, and to constitute a tool for predicting the probable impact of existing trends and policy options. This requires that information be available not only about water resources, both from a quantity and a quality point of view, but also about the probable effect of water resources development and utilization on other variables such as land use, land degradation, biodiversity and climate change. If this type of understanding is to be achieved, there is a need for an approach to data management that links physical, hydrological and hydrogeological information (concerning both quantity and quality) with water-use data, demographic information, land-use and degradation data, data concerning the use of pesticides and fertilizers, industrial production data, and other relevant variables.

7. If data are to become useful as a means of providing information about areas at risk and areas of opportunity, they have to be linked very closely to the concrete geographical units to which they refer. Data tend to lose their information value as their geographical context becomes more diffused. Ideally, water resources-related data should be collected and analysed within the context of the watershed or the groundwater basin. Failing that, political or administrative units at varying levels of aggregation can function as the basic integrating unit. While hydrologic and hydrogeologic data, including water-quality data, are normally treated in the context of the river or groundwater basin, this is not the case for other types, such as information on water-supply and sanitation service coverage, and demographic and economic data, which are usually collected at the level of the administrative political unit, or even at the national level. Although such data can still be very useful as indicators of certain trends, efforts need to be made, to the extent feasible, to organize the collection of data at the level of the smallest convenient unit which can then be related to the individual watershed or groundwater basin.

II. INFORMATION MANAGEMENT ISSUES AT THE NATIONAL LEVEL

A. The current situation

8. Many developing countries currently lack the capacity needed for the collection, collation, analysis and display of the information required for the holistic management of water resources in the context of sustainable development. This is often due to a lack of reliable data in a suitable form and of horizontal and vertical integration among governmental organizations dealing with various aspects of water resources development and management, and among those dealing with socio-economic planning.

9. With regard to the assessment of water resources, the reviews carried out in the context of the follow-up of the Mar del Plata Action Plan, and more particularly the review carried out in 1990 for the purpose of formulating a strategy for the implementation of the Action Plan in the 1990s, showed that there were still considerable deficiencies in the availability of data, particularly with regard to groundwater and water quality. In many instances, data-gathering hydrologic organizations have fallen prey to the budgetary constraints of the 1980s. In fact, as evidenced by the recent series of hydrologic assessments of sub-Saharan Africa, the hydrologic organizations over most of the African continent have reached a nadir in terms of activity and functionality. Expenditure and maintenance budgets have been cut consistently and there remain very few well-maintained surface-water monitoring stations throughout the continent.

10. Efforts in the field of hydrologic data management have concentrated on the operational aspects - data collection and data processing - that is, on the production of data. Little attention has been paid to the elements of data management in the post-processing stages, such as those of data manipulation, evaluation of user needs, and reporting and dissemination (in other words, data consumption). It may be that part of the financial and institutional problems experienced by water resource organizations have to do with those organizations' lack of regard for the data consumer. On the other hand, the reluctance on the part of some Governments to publish data often means that potential consumers of such data are unaware of what is available. Indeed, it is the demand for data that should (along with statutory requirements) drive their production and thereby lead to the allocation of necessary resources to data-gathering organizations. To arrive at this stage will necessarily involve an appraisal of the technical and political issues related to data management and dissemination.

Climatological data

11. Climatological data management is generally well developed, with programmes such as the National Oceanic and Atmospheric Administration (NOAA) Climate Computing (CLICOM) constituting an unofficial international standard. An important aspect of the CLICOM programme is connected with the adoption of a commercially available database (Dataease) with which climatological applications are constructed. The National Oceanic and Atmospheric Administration is therefore not itself responsible for the code; this remains the responsibility of a commercial company that offers quality assurance, technical support and upgrades.

/...

Hydrologic data

12. Management of hydrologic and hydrogeologic data, on the other hand, is not so highly developed. Much hydrologic and hydrogeologic database compilation is project-oriented and rarely standardized. Moreover, much of the data have been and are being processed and managed in custom-built software packages developed for mainframe computers by hydrologic scientists and engineers (but rarely by formally trained software engineers), who are usually from research institutes. The initial training and maintenance costs for these packages are often high, with programme costs amounting to tens of thousands of dollars. Moreover, they do not reflect the inclusion of the thorough quality assurance procedures and upgrades that have become the norm in commercial software houses.

13. The proliferation of a wide range of these non-commercial and non-professional packages continues. Very few have standard means for transferring data other than standard American Standard Code for Information Interchange (ASCII) file transfers; therefore data will always lose structure and relationships when exported to other packages. The result is that much expensively acquired hydrologic data ends up in equally expensive and not always reliable electronic forms, often underused, underanalysed and rarely shared.

Physiographic and land-use data

14. To the extent that physiographic information and information on land use and land degradation are available, they need to be coupled with water resources data. Considerable interest has been shown by earth scientists and those concerned more generally with natural resources in the integration of remote sensing data and geographical information systems. There now exist several well-established companies that produce hardware and software systems to carry out precisely such integration. There are a number of United States- and Europe-funded satellites able to provide weather and atmospheric flow data in some areas to countries with a "down link". Those data provide some basic information even though they may not be totally accurate without ground truth. Remote sensing imagery is also useful for providing land-use and environmental data.

Digital imagery

15. For the most part, satellite sensing systems for earth science applications collect multi-temporal digital imagery that can be made available to the consumer on magnetic media in a preprocessed format, that is, a corrected and geometrically rectified one. The data can be further processed interactively to aid interpretation through the use of image processing software and high-resolution monitors. In the past this imagery has been interpreted manually by using a series of acetate overlays and scribed masks to compile conventionally printed cartographic products. More recently, the ability to interpret the raster imagery directly on high-resolution monitors and store the electronically traced lines, points and polygons as vector overlays for input into geographical information systems has been developed on personal computer-based systems. As costs of computing power and memory continue to be reduced, the application of that ability becomes progressively cheaper and, in theory, more cost-effective.

16. Multi-temporal satellite data can provide relatively cheap synoptic views of these resources, and geographical information systems can furnish the ability to quantify and analyse the nature of the distributions. It is important to bear in mind, however, that raw satellite data are inaccurate. The atmosphere between the satellite sensors and the reflective surface of the Earth is hundreds of kilometres (km) thick and contains continuously variable amounts of condensed water, atmospheric gases and dust. There is significant atmospheric attenuation and scattering of both incident and reflected radiation. Consequently the measured spectral response of the Earth's surface to sunlight at an altitude of 914 km (in the case of Landsat satellites) is very different from that of a spectrometer held a few metres above the same surface at the same time. Not surprisingly, the raw satellite data need to be corrected and rectified before they are ready for interpretation. The suppliers of most remote sensing data will carry out standard image restoration to compensate for data errors, noise, geometric distortion and atmospheric effects. The objective is to make the image resemble that produced by human perception of the original scanned scene. A commercially available satellite image thus becomes an observation to which a largely unquantifiable level of error is attached. The degree, then, to which any preprocessed image can be regarded as an objective record of the state of the Earth's surface at a particular time is clearly limited.

Socio-economic data

17. To the extent that socio-economic data are available they are seldom related to water resources, and even less so in terms of spatial relationships as related to watersheds or groundwater basins. The situation is particularly serious in terms of water-demand data and water-use patterns, especially in a number of countries that are known to be critically water-short, or close to becoming so. The collection, processing and analysis of water-demand and water-use data on a location-specific basis need to be given priority consideration in many developing countries, particularly those located in water-scarce regions.

Geographical information systems

18. From a technological point of view, the decade of the 1980s witnessed a rapid evolution in the field of electronic data processing to the point where the hardware and software required for integrated data management have now become widely available at relatively low cost. There are currently a variety of computerized geographical information systems (GIS) that facilitate the storage and processing of spatial information. There is clearly a need to develop geographical information systems for natural resource monitoring and evaluation. Natural resources are distributed in space and in time, and multi-temporal satellite data can provide relatively cheap synoptic views of those resources. Geographical information systems can furnish the ability to quantify and analyse the nature of the distributions. It is important, however, to temper this realization with an appreciation of the inherent limitations of the data and analysis systems, and of the need for support in digital cartography. The database structure needs to be considered carefully and note taken of the fact that conventional database languages such as structured query language (SQL) may not necessarily be suited to spatial queries. The original mapping base needs to be digitized, and points, lines

and polygons stored as vectors consume a significant amount of computer memory. The work of digitizing is time-consuming but must be meticulously executed if it is to be worthwhile; coordinate transformations of data need to be carried out to ensure conformity of data derived from other digitized projections; and physiographic boundaries need to be matched with administrative and political ones. Given the above-mentioned considerations, it is important, prior to any investment in such systems, to determine that the objectives of the projects to be executed are indeed based upon a clear understanding of the data and the systems. Failure to so proceed will result in a raising of the expectations of project executors and consumers beyond a level commensurate with technical feasibility.

**B. Proposals for enhancing capacity-building
at the national level**

19. The United Nations is in the process of formulating a capacity-building programme aimed at assisting Governments in the management of information for water resources management. This is being initiated with a view to optimizing economic and social development, while ensuring environmental sustainability. The programme would be implemented in cooperation with the United Nations Development Programme (UNDP) and the various organizations of the United Nations system. Although global in concept, it could be implemented at the national level by means of replicable pilot studies.

20. A feasibility study on developing multi-system interfaces to interconnect state-of-the-art expert or geographical information systems with existing conventional databases was initiated by the Department of Economic and Social Development of the United Nations Secretariat in 1992. The study may lead to the design of interface systems that could enable national planning authorities to make the best use of both modern technology, including decision-making tools like expert systems, and a variety of individual databases on different systems. It is expected that the feasibility study will be completed in the latter part of 1993.

21. Following the completion of this study, it is envisaged that a preparatory assistance phase will be initiated during which a prototype multi-system interface would be field-tested through a pilot programme carried out in a few countries. Subsequently, a capacity-building programme - in which information needs and existing databases would be surveyed, tailor-made information systems designed and the appropriate computer hardware and software, including the necessary interface system, determined - would be designed and implemented at the country level. Institutional constraints related to information management would be examined with a view to strengthening technical capacities where needed, and improving horizontal and vertical institutional integration. Training of staff in the use of economic water planning models would be provided.

22. Upon completion of the preparatory assistance phase of the programme and a refining of the procedures, the convening of a conference of national experts and external support agencies is envisaged, aimed at building a consensus on this approach to capacity-building in the field of information management based on the experience gained during the initial phase. Following the agreement of

/...

all parties to the further development of the programme and to its design, it is anticipated that a number of initiatives could be set in motion and financed either separately or under a umbrella-type trust fund programme.

III. INFORMATION MANAGEMENT AT REGIONAL AND GLOBAL LEVELS

23. The monitoring of progress achieved in the implementation of the Mar del Plata Action Plan and of issues concerning the development, management and utilization of water resources has been a central focus of the activities of the Committee on Natural Resources and of the General Assembly during the 1980s. These monitoring activities of the organizations of the United Nations system in response to the requirements of intergovernmental bodies led to the preparation of regional surveys concerning the implementation of the Action Plan, the preparation of a strategy for its implementation in the 1990s, ^{2/} and the preparation of the report of the Economic and Social Council (A/45/327) to the General Assembly on the achievements of the International Drinking-Water Supply and Sanitation Decade (1981-1990). In addition, individual organizations have reported to their intergovernmental governing bodies on specific issues pertaining to their own fields of endeavour.

24. At the present time, the monitoring of water resources-related issues takes on an added dimension and sense of urgency in the light of Agenda 21. If an adequate follow-up of the Mar del Plata Action Plan into the 1990s, and of the provisions of Agenda 21 concerning freshwater resources, is to take place, the relevant intergovernmental bodies will require periodic analytical reports on the state of the freshwater resources of the world.

25. The experience of the 1980s with regard to the monitoring of progress in the implementation of the Mar del Plata Action Plan has demonstrated that the information put together for reporting purposes was, for the most part, inadequate and superficial, particularly concerning what appear to be the main issues. The available information did not lend itself to processing in a manner sufficiently comprehensive to generate more specific analyses for identifying or anticipating problems affecting or likely to affect given locations. More important, that information did not provide the tools for achieving an understanding of the interrelationship of important variables affecting the sustainable development and utilization of water resources, nor did it satisfy the need to provide the intergovernmental process with information suitable for identifying priority areas for action, and bringing about an effective process of policy formulation at national, regional and global levels.

26. Even though there is a serious lack of data in some areas, such as those of water demand and of water-use patterns on a location-specific basis, as well as of information concerning the location and size of hydroelectric plants, a number of data-gathering programmes exist within and outside the United Nations system. Many have performed invaluable services within their specific fields, and others are undergoing continuous growth. Some of those programmes (to mention a few) are listed below:

Water and Sanitation Monitoring System (WASAMS), United Nations Children's Fund (UNICEF)/World Health Organization (WHO)

/...

Environmental Health Management Information System (EHMSYS), WHO

Global Resource Information Database (GRID), United Nations Environment Programme (UNEP)

Global Environmental Monitoring System/water-quality data (GEMS/WATER), WHO/UNEP

Global Run-off Data Centre (GRDC), World Meteorological Organization (WMO)

Hydrological Information Referral Service database (INFOHYDRO), WMO

CLICOM and World Climate Data Information Referral Service (INFOCLIMA) databases, WMO

Africa Real Time Environmental Monitoring using Imaging Satellites programme (ARTEMIS), Food and Agriculture Organization of the United Nations (FAO)

Demographic, economic and social indicators, United Nations, World Bank

Health indicators, WHO

27. Information is also available in various organizations, including the regional commissions, concerning institutional arrangements as they relate to water resources among national or regional river basin organizations. This information has not, however, been compiled in a systematic database. Information concerning agreements on shared river basins has been collected by FAO and the Department of Economic and Social Development of the United Nations Secretariat, which is in the early stages of developing a computerized database in this area.

28. National and local information is also being gathered and analysed by national authorities in many developing countries, often with the support of external support agencies, although dissemination and exchange of these valuable data are inadequate or non-existent. Some examples of these national or local programmes, to mention only a few in the critical region of Africa, are given below:

(a) The Programme for Water, Soil, Fertilization, Irrigation and the Mechanization of Agriculture (ESFIMA), carried out under the aegis of the Ministry of Higher Education and Research of Burkina Faso, which is aimed at the control of desertification through the study of soil erosion, and of the relationships between water, soil and plants, and chemical, organic and biological fertilization;

(b) The Earth Resources Survey Project (PIRT), established by an agreement between the Government of Mali, the United States Agency for International Development, and the Aid and Cooperation Fund of France, which is overseen by the Ministry of Environment and Livestock of Mali. Its initial objectives were to survey the natural resources of Mali on the basis of Landsat images, and to train local staff;

(c) The Project for the Mapping and Remote Sensing of the Resources of the Republic of Senegal, carried out by the Department of Land Development of Senegal, with the financial and technical assistance of the United States Agency for International Development, whose aim was to produce maps from Landsat images interpreted visually for various themes, including vegetative cover, hydrogeology and land use;

(d) The Multidisciplinary Working Group for the agro-hydrometeorological monitoring of the agricultural season in the Niger, which was set up under the aegis of the WMO AGRHYMET (Agrometeorology and operational hydrology and their applications) Regional Centre in Niamey, and is overseen by the Director of the National Meteorological Department of the Niger;

(e) The Project for the Dynamic Mapping of Desertification in the Menzel Habib Region of Tunisia, conducted by the National Remote Sensing Centre of Tunisia, with the assistance of a French remote sensing user group and the Tunisian Ministries of Agriculture and Defence, whose main objective is to use dynamic mapping to monitor environmental changes;

(f) The Remote Sensing Programme, carried out by the Soil and Water Research Institute of Egypt with the support of the Canadian International Development Association (CIDA) and McGill University in Canada, which interprets Landsat and Experimental Earth Observation Satellite (France) (SPOT) satellite data in order to provide support to the Institute's activities, such as soil mapping, and land-use and water resources management;

(g) The Integrated Programme on Arid Lands, carried out by the University of Nairobi in collaboration with the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Government of Switzerland, which involves the use of remote sensing based on Landsat and SPOT satellite images;

(h) The National Meteorological Service Agency of Ethiopia, formerly under the National Water Resources Commission, which studies and supplies information on the country's climate with a view to understanding the meteorological systems that affect the country.

29. The Administrative Committee on Coordination (ACC) Intersecretariat Group for Water Resources, at its thirteenth session held in October 1992, recognized that while existing programmes were very useful in terms of the specific purpose for which they had been designed, they did not provide a system capable of synthesizing the data into an organic whole with a view to determining gaps in knowledge, analysing existing data in order to determine risks levels of specific areas and formulating strategies for further information-gathering. The members of the Group agreed that in spite of the data available in various databases, the capability to make a meaningful assessment of the state of the world's freshwater resources did not exist at the present time. The members of the Group agreed on the importance of establishing a system capable of integrating available information concerning various aspects of water resources development and utilization. The Group expressed its awareness of the complexities involved in developing an integrated database system, and of the fact that it would require the commitment of financial resources. Consequently, the participants stressed the need to proceed in a gradual and incremental manner, with well-defined objectives. Such a system should be

/...

flexible and demand-driven at all times, in order to ensure its relevance to the needs of the international community.

30. The members of the Group agreed on the importance of establishing a suitable methodology for carrying out work in the area discussed above, in order to define its focus and ensure its relevance. They agreed to consider at the next session of the Group measures that should be taken towards the possible establishment of a system-wide integrated monitoring and assessment network. They also envisaged the possibility of convening an expert consultation at a later stage. Consequently, a working group of the ACC Intersecretariat Group for Water Resources, under the chairmanship of WMO, and composed of the United Nations, UNEP, UNICEF, UNESCO, FAO, WHO, the World Bank and WMO, was entrusted with the task of identifying both existing relevant databases for the purpose of defining the issues involved in integrating their data (including such questions as that concerning the division of databases among those concerned with the resource itself, and those dealing with its use), and the various elements that should be considered in defining the basic methodology for the system, such as health, economic indicators, land-use indicators, food production and population, as well as the ways in which those elements should be classified and managed. The working group, which is scheduled to meet in June 1993, will consider the steps to be taken in the preparatory phases of the process concerning methodological approaches, including estimates of the financial resources that might be required in setting up the system.

Notes

1/ See Report of the United Nations Water Conference, Mar del Plata, 14-25 March 1977 (United Nations publication, Sales No. E.77.II.A.12), chap. I, paras. 41 and 44 (d).

2/ See Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992, vol. I, Resolutions Adopted by the Conference (A/CONF.151/26/Rev.1), chap. 18, para. 18.6.

3/ Ibid., para. 18.12 (b).

4/ Ibid., para. 18.12 (c).

5/ Ibid., chap. 40, para. 40.3.

6/ Ibid., para. 40.5 (b).

7/ See document E/C.7/1991/8, sect. III.
